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$TITLE: M4-3a.GMS: modeling health insurance
*    with moral hazzard, adverse selection modeled as a NLP
* COPYRIGHT JAMES R. MARKUSEN AND DAVID WHITEHILL

$ONTEXT
MODELING DEMAND FOR HEALTH INSURANCE
                                                        |---Sick
          |--Do not buy Insurance--choose effort --|
          |                                             |---Healthy
Income---|
+ Type    |                                             |---Sick
          |--   Buy Insurance    --choose effort---|                    »
                                |---Healthy
$OFFTEXT

PARAMETERS
 TYPE     risk type (higher number - safer type)
 M0       income in the first time period
 MH       income in the second time period when healthy
 MS       income in the second time period when sick (before insurance)
 ACUF     acutuarially fairness   1 = actuarily fair  ACUF < 1 unfair
 BETA     needed to make the consumption concave(diminishing returns)
 INS0, PNS0, ALPHA0, EFFORT0, PROFIT0  store results for single type
 INS1, PNS1, ALPHA1, EFFORT1, PROFIT1  store results for type 1 (safe)
 INS2, PNS2, ALPHA2, EFFORT2, PROFIT2  store results for type 2 (risky)
 PROFIT   profit of the insurance firm selling to both types;
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ACUF=1.0;
BETA = 0.5;
M0 = 10;
MH = 10;
MS = 4;
TYPE = 0.5;

NONNEGATIVE VARIABLES
 INS      insurance purchased
 PNS      payoff from insurance when sick
 ALPHA    probability of good health
 EFFORT   effort spent to insure good health: diet exercise and such;

VARIABLES

 U        expected utility;

EQUATIONS

 UTILITY   the utility of having or not having insurance
 INSURANCE the amount of insurance puchases
 MORALHAZ  relationship between effort and probability of being healthy;


UTILITY..    U =E= (M0-INS)**BETA
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                    + ALPHA*MH**BETA + (1-ALPHA)*(MS+PNS)**BETA
                    - 0.1*(0.3 + EFFORT)**2;

INSURANCE..  PNS*0.5 =E= INS*ACUF;

MORALHAZ..   ALPHA =E= TYPE + 0.15*EFFORT;


MODEL OPTIMIZE /UTILITY, INSURANCE, MORALHAZ/;

U.L = 1;
INS.L =2;
PNS.L = 1;
ALPHA.L = 0.5;
EFFORT.L = 0;

*solve first for single type
TYPE = 0.5;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;

INS0 = INS.L;
PNS0 = PNS.L;
ALPHA0 = ALPHA.L;
EFFORT0 = EFFORT.L;
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PROFIT0 = INS0 - (1 - ALPHA0)*PNS0;

DISPLAY INS0, PNS0, ALPHA0, EFFORT0, PROFIT0;

*now assume two types, solve first for the safe type
TYPE = 0.55;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;

INS1 = INS.L;
PNS1 = PNS.L;
ALPHA1 = ALPHA.L;
EFFORT1 = EFFORT.L;

PROFIT1 = INS1 - (1 - ALPHA1)*PNS1;

DISPLAY INS1, PNS1, ALPHA1, EFFORT1, PROFIT1;

*solve for the risky type
TYPE = 0.45;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;

INS2 = INS.L;
PNS2 = PNS.L;
ALPHA2 = ALPHA.L;
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EFFORT2 = EFFORT.L;

PROFIT2 = INS2 - (1 - ALPHA2)*PNS2;

DISPLAY INS0, PNS0, ALPHA0, EFFORT0, PROFIT0;
DISPLAY INS1, PNS1, ALPHA1, EFFORT1, PROFIT1;
DISPLAY INS2, PNS2, ALPHA2, EFFORT2, PROFIT2;

PROFIT = PROFIT1 + PROFIT2;
DISPLAY PROFIT;


* generate some scenarios

SETS I /I1*I7/;

PARAMETERS
 RESULTS(I, *);


SOLVE OPTIMIZE USING NLP MAXIMIZING U;
RESULTS("I1", "INS")  = INS.L;
RESULTS("I1", "ALPHA")  = ALPHA.L;
RESULTS("I1", "EFFORT") = EFFORT.L;
RESULTS("I1", "ACUF") = ACUF;
RESULTS("I1", "IS")  = MS;
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RESULTS("I1", "BETA")  = BETA;

*Actuarially unfair added
ACUF = 0.7;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;
RESULTS("I2", "INS")  = INS.L;
RESULTS("I2", "ALPHA")  = ALPHA.L;
RESULTS("I2", "EFFORT") = EFFORT.L;
RESULTS("I2", "ACUF") = ACUF;
RESULTS("I2", "IS")  = MS;
RESULTS("I2", "BETA")  = BETA;

*Loss from getting sick is higher

ACUF = 1.0;
MS = 2;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;
RESULTS("I3", "INS")  = INS.L;
RESULTS("I3", "ALPHA")  = ALPHA.L;
RESULTS("I3", "EFFORT") = EFFORT.L;
RESULTS("I3", "ACUF") = ACUF;
RESULTS("I3", "IS")  = MS;
RESULTS("I3", "BETA")  = BETA;
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*Risk aversion is higher

MS = 4;
BETA = 0.4;
INS.L = 2.5;
ACUF = 0.7;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;
RESULTS("I4", "INS")  = INS.L;
RESULTS("I4", "ALPHA")  = ALPHA.L;
RESULTS("I4", "EFFORT") = EFFORT.L;
RESULTS("I4", "ACUF") = ACUF;
RESULTS("I4", "IS")  = MS;
RESULTS("I4", "BETA")  = BETA;

*Homogeneity in income?
M0 = 20;
MH = 20;
MS = 8;
BETA = 0.5;
ACUF = 1.0;

SOLVE OPTIMIZE USING NLP MAXIMIZING U;
RESULTS("I5", "INS")  = INS.L;
RESULTS("I5", "ALPHA")  = ALPHA.L;
RESULTS("I5", "EFFORT") = EFFORT.L;
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RESULTS("I5", "ACUF") = ACUF;
RESULTS("I5", "IS")  = MS;
RESULTS("I5", "BETA")  = BETA;

DISPLAY RESULTS;
```